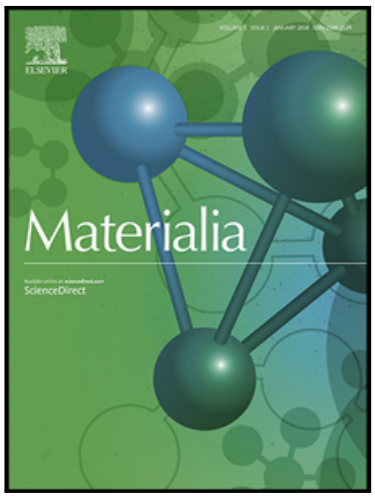

Nanostructure Stability and Nano-Phase Separation Sintering in the Titanium-Magnesium System

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Nanostructure Stability and Nano-Phase Separation Sintering in the Titanium-Magnesium System

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Abstract:

Nanocrystalline metals have certain property advantages over their microcrystalline counterparts due to their high grain boundary content, but they are difficult to process in bulk forms without suffering detrimental grain growth. This study evaluates candidates for thermodynamic stabilization of a nanocrystalline state in Ti alloys through the formation of a "nanoduplex" structure, and identifies the Ti-Mg system as worthy of exploration. The structural stability and sintering behavior of nanocrystalline Ti-Mg powders produced by mechanical milling are investigated. Structural stability of the nanocrystalline state is retained to high temperatures for hours. A grain growth kinetic scaling law similar to microcrystalline duplex alloys was found. Furthermore, accelerated sintering of cold pressed samples was achieved through nanophase separation, leading to relative densities of more than 95 % at processing temperatures below 600º C, even while retaining an ultrafine grain size.

Keywords: thermodynamic stabilization, nanoduplex structure, Ti-Mg alloys, accelerated nanophase separation sintering

1. Introduction

Lightweight alloys with a nanocrystalline structure can offer large weight savings and superior properties compared to their microcrystalline counterparts [1]–[5]. However, nanocrystalline alloys have not achieved significant technological penetration to date for many reasons, including a lack of thermal stability [3], [6]–[12], and a shortage of viable processing routes to produce them in bulk form [13]. One approach for producing nanocrystalline powders in large quantities is high-energy milling [14]–[18].